AMENDMENTS TO THE SPECIFICATION

Please amend the specification, as set forth below to correct various informalities. The revisions do not introduce new matter.

Please amend the paragraph beginning on Page 4, line 25 as follows:

A1

The method of increasing the accuracy of a machine for performing machining operations on a work-piece, the machine having a movable head containing a tool for performing the machining operations on the work-piece, the head movable to predetermined positions directed by a computer program within a computer, includes the steps of:

Please amend the paragraph beginning on Page 5, line 10 as follows:

A2

The method of using the second embodiment involves the steps of:

1. Continuously determining the actual spatial relationship between the carriage and work-piece and providing a ~~second~~ first signal representative thereof;
2. Continuously determining the actual spatial relationship between the head and work-piece during the performance of machining operations and providing a ~~third~~ second signal indicative of the actual position;
3. Continuously determining the actual spatial relationship of the work piece during machining operations and providing a third signal indicative thereof; and
4. Adjusting the spatial relationship of the head based on the difference between the first, second and third signals.

Please amend the paragraph beginning on Page 7, line 18 as follows:

A3

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In detail, the laser transceiver ~~tracking~~ assembly 22 transmits a laser beam, indicated by numeral 26 to the laser targets 24A-C mounted on the work-piece 10 and is directed back to the laser transceiver ~~tracking~~ assembly 22. An interferometer interferes the source beam with the beam ~~26~~ that has traveled twice between the laser transceiver assembly 22 and targets 24A-C in order to measure the separation. By measuring the directions of the beams 26 relative to the ~~to~~ targets 24A-C, the targets 24A-C can be located in spatial coordinates and additionally the orientation of the targets 24A-C can be determined. The measurements are fed to a laser-

A3 cont'd

tracking computer (not shown), which is able to calculate the spatial coordinates of the ~~tool~~ work piece 10. Systems based on this technology are commercially available. It must be noted that while three laser targets are shown, in some applications a single target may be adequate.

Please amend the paragraph beginning on Page 8, line 1 as follows:

A4

The machine 19 further includes a portable carriage 28 having a robotic arm assembly 30 mounted on top. The carriage 28 includes wheels 32, stabilizing jacks 34 and a computer 36. As illustrated the robotic arm has a tool head 38 in which is mounted a tool ~~cutter~~ 40, such as a cutter. Robotic arms are commercially available from companies such as Fanuc Robotics, Rochester Hills, MI. The front face 42 of the carriage 28 includes three laser targets 44A, 44B and 44C in a spaced relationship; although in some applications, a single target can be used. While the targets 44A-C are shown positioned on the front face 42 other positions are possible such as on the top surface 43. The carriage 28 is wheeled up to the work-piece 10 and locked in place by the jacks 34. Preferably, the carriage 28 is positioned in a predetermined optimum position in relationship to the work-piece 10. This optimum position would be the position of carriage as originally set in the machining program in the computer 36. However, even if the carriage 28 is set with precise hand measurements, they will not generally be precise enough, such that compensation for positional error must be taken into account.

Please amend the paragraph beginning on Page 8, line 28 as follows:

A5

As previously stated, the carriage ~~10~~ 28, even if locked in place by the jacks 34, may move and the robotic arm assembly 30 may introduce inaccuracies, and the work-piece 10 is not necessarily on a rigid platform, as in the case of a typical milling machine or the like. Therefore, it is possible that such movement, even if extremely small, could cause inaccuracies in the machining operations. Thus a laser target 46 is mounted on the head 38 of the robotic arm assembly 30. The laser transceiver assembly 22 uses the target 46 to locate the actual spatial relationship of the head 38 during actual machining operations. This information is provided to the computer 36, which continuously adjusts the position of the head 38 so that it is in the required spatial relationship to the work-piece 10.

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Please amend the paragraph beginning on Page 9, line 10 as follows:

~~In Figure 4 is a~~ Figures 4A and 4B show a flow chart of the machining process. The flow chart is divided into four sections:

1. Set up 50, wherein the work-piece and carriage positions are determined. The carriage 28 is wheeled into position in proximity to the work-piece 10. Once in position, the jacks 34 are engaged so that all the weight of the carriage 28 is on the jacks. Note, while desirable, the carriage 28 need not be level or in a particular orientation. The laser alignment system 20 is used to determine the position of the work-piece 10 and carriage 28. The data on the coordinates of both the work-piece 10 and carriage 28 are used to update the computer program within the computer 36 for machining the work-piece 10.

Please amend the paragraph beginning on Page 9, line 21 as follows:

2. Pre-Processing 52, wherein the computer processes the positional information and updates the machining program. The position information is stored in the computer 36 and is used to calculate a coordinate transformation matrix that will be applied to adjust the robotic arm assembly 30 to machine the work-piece 10. This allows the tool head 38 ~~40~~ to be moved to any position necessary to perform the machining operations on the work-piece 10.

Please amend the paragraph beginning on Page 9, line 28 as follows:

3. In-Situ Processing 54, wherein the work-piece 10 is machined with the laser transceiver ~~tracker~~ assembly 22 providing head 38 position information to correct for errors. Prior to machining operations, transceiver assembly 22 will focus on the target 46 on the head 38 of the robotic arm assembly 30 and go into a live feedback tracking mode. The robotic arm assembly 30 will follow the preprogrammed computer program that has been modified by the incorporation of actual positions of the carriage 28 and work-piece 10. However, the transceiver assembly 22 receives real-time head 38 spatial relationship information. If there is a deviation, the computer program calculates a difference or offset matrix and uses it to "real time" re-position the head

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A8 cont'd

38 to the required position. This process is updated several times a second insuring a smooth machining operation.

Please amend the paragraph beginning on Page 10, line 10 as follows:

A9

4. Post Processing 56, wherein the work-piece is inspected. After the machining operation, the robotic arm assembly 30 is used to inspect the work-piece 10. It will replace the tool ~~cutter~~ 40 with an inspection target (not shown). The transceiver assembly 22 tracks the inspection targets' position as the now the machined work-piece is probed. In detail, the flow chart is as follows.

Please amend the paragraph beginning on Page 10, line 16 as follows:

A10

Section 1, Set up 50 involves steps of:

Step 60 - Set up carriage 28 and alignment system 20 in proximity to the work-piece 10.

Step 62 - Determination of positional relationship of work-piece 10 to the robotic arm assembly 30 of the carriage 28 and provides the information to the computer 36.

Please amend the paragraph beginning on Page 10, line 22 as follows:

A11

Section 2, Pre-Processing 52 involves the steps:

Step 64 - Store positional information in computer 36.

Step 66 - ~~Perform coordinate transformation to~~ ~~generate~~ Generate coordinate transformation matrix.

Step 68 - Update machining program using transformation matrix.

Please amend the paragraph beginning on Page 10, line 28 as follows:

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A12

Section 3, In-Situ Processing 54 involves the steps of:

Step 70 - Transceiver assembly 22 tracks target 46.

Step 72 - Machine to preprogrammed path.

Step 73 - Measure actual position of head

Step 75 - Determine if head 38 is at proper position. Computer program determines deviation between actual head position and desired position. If the head 38 is at the proper position, to Step 76.

A12

Step 76 - Determine if machining is complete. If complete then to Step 78 of Post Processing 56 Section. If machining is not complete then go to Step 72 ~~80~~.

Step 80 - Generate a delta transformation matrix and calculate offsets. Thereafter return to Step 72

Please amend the paragraph beginning on Page 11, line 10 as follows:

Section 4, Post Processing 56

Step 78 - Robotic arm assembly 30 replaces tool ~~cutter~~ 40 and inserts a spring loaded laser target (not shown)

A13

Step 82 - Machine work-piece inspected.

Step 84 - Record measured data

Step 86 - compare measured data with desired surface contour. If not within tolerance, return to step 80, if within tolerance then job is complete.

Please amend the paragraph beginning on Page 12, line 11 as follows:

Referring to Figure 7, the process is similar to that disclosed in Figure 4B except the In-Situ Processing Section, now indicated by numeral 54', includes a "Step 73A Determination of actual position of work-piece" between "Step 73 - Determine if head is in proper position" and "Step ~~74~~ 75 - Is head ~~mill~~ at ~~proper~~ correct position ~~74~~". In Step 73A, the laser transceiver assembly 100B tracks the targets 24A, B and C to determine if the work-pieces 90A-C have ~~has~~ moved from ~~its~~ their initial position.

A14

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Please amend the paragraph beginning on Page 12, line 19 as follows:

A15

Thus the invention can be used to perform machining operations on a work-piece. In the first embodiment, it can accommodate ~~movement~~ inadvertent movement between the

work-piece and carriage. In the second embodiment, the machine can accommodate continuous movement between the carriage and work-piece. Furthermore, while a conveyor system was shown for purposes of illustration, a basically stationary work-piece, subject to small movements, could easily be accommodated. Additionally, it should also be noted that while the machining operations discussed were milling, hole drilling or other operations can be performed with the machine.

A15 Contr

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